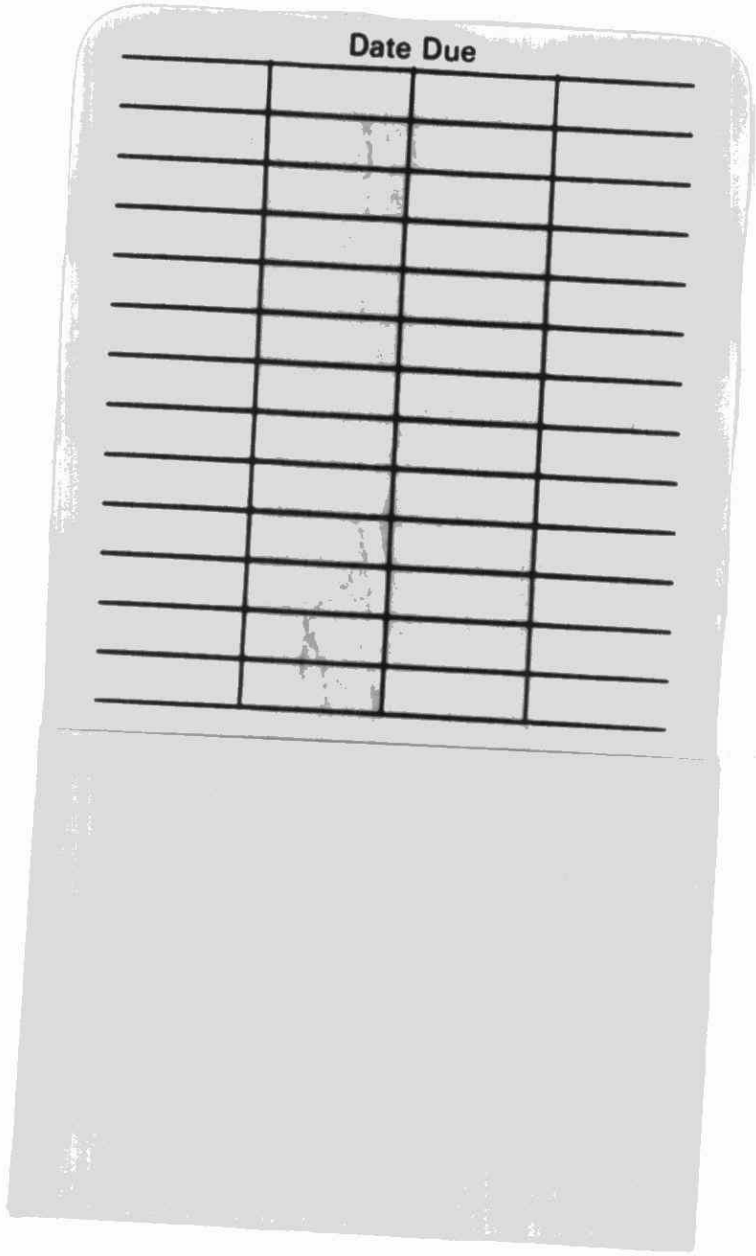
AN ASSESSMENT OF PESTICIDE RESEARCH PROJECTS

Funded by the Ministry of the Environment through the Ontario Pesticides Advisory Committee

1978 - 1979

Ontario

The Ontario Pesticides Advisory Committee



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THE MINISTRY OF THE ENVIRONMENT

THROUGH

THE ONTARIO PESTICIDES ADVISORY COMMITTEE

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RESEARCH PROJECTS FUNDED THROUGH THE ONTARIO PESTICIDES ADVISORY COMMITTEE

1978-79

I. SUMMARY

1) In 1978-79 the Ontario Pesticides Advisory Committee continued a program, begun in 1973, of funding research on pesticides. The objectives of the program are:

   a) To find alternative pesticides for those seemed environmentally hazardous and thus restricted in use.

   b) To determine potential environmental hazards with pesticides currently in use.

   c) To reduce pesticide input into the environment.

2) Thirty-nine applications for research support, totalling $723,184 were received.

3) Twenty research proposals were funded with a total value of $446,300. Awards ranged in value from $1,100 to $170,000.

4) Five grants totalling $83,200 were awarded for studies on development of alternative pesticides for pest control.

5) Nine grants totalling $71,500 were allocated to studies on the behaviour and fate of pesticides in the environment and on potential environmental hazards to non-target organisms.

6) Six grants totalling $291,600 were allocated for studies aimed at reducing pesticide input into the environment while still achieving effective pest control.

7) The Pesticides Advisory Committee is very satisfied with the research progress made in 1978-79. It recognizes that with the limited funds available the program of grants can be expected to act only as a catalyst in stimulating research in the broad areas indicated in the Committee's guidelines for which there is still an urgent requirement.

II. RECOMMENDATIONS

The Pesticides Advisory Committee recommends that:

1) The Ministry of the Environment continue to support research programs directed toward development of pest control programs which will not pose any serious environmental hazard.

2) The program continue to be supervised by the Pesticides Advisory Committee following the guidelines which have been developed.

III. REVIEW OF THE RESEARCH PROGRAM

In 1973 the Ministry of the Environment allocated funds to the Ontario Pesticides Advisory Committee to sponsor pesticide research. Results obtained have been summarized in annual reports (OPAC 1974, 1975, 1976, 1977, 1978). A five-year assessment of progress was included in the 1978 report. Results obtained to date have encouraged the committee to recommend that the research program be continued under its supervision. The committee is gratified that this recommendation has been accepted. In 1978-79 two other reseach programs supported by the Ministry of the Environment were placed under the supervision of the Pesticides Advisory Committee. The combined research budget for these three programs in 1978-79 was $460,000.

Initially the Advisory Committee developed terms of reference to govern the awarding of research grants based on three objectives, i.e. the need to find suitable replacements for pesticides deemed hazardous and restricted in use in Ontario; the need to determine if pesticides presently in use pose any serious environmental hazard; and the need to develop more effective approaches to pest control leading to a reduction of pesticide input into the environment. The "Application for Research Support (Appendix I) based on these objectives, invited proposals for studies on: 1) development of environmentally acceptable pesticides (Objective 1); 2) the fate and biological significance of pesticides in the environment, including development of information on time which should elapse between dates of treatment and reentry into treated areas, and on human exposure to pesticides (Objective 2); and 3) economics of pest control including economic threshold levels of pests, reduction of pesticide use through development of effective pest monitoring and pesticide application techniques, and alternative integrated or non-chemical methods of control (Objective 3). Invitations for applications for research support were distributed in January 1978 to personnel in Ontario universities, industry, and government (copies of the mailing list are available on request) with deadlines for applications being February 10, 1978.

Thirty-nine research proposals totalling $723,184 were received. Thirty-five were from universities (Guelph - 18, Waterloo - 4, Western - 6, York - 4, Brock - 1, Carleton - 1, Ottawa - 1). Four applications were received from industry. (A list of titles of research proposals submitted to the Pesticides Advisory Committee for consideration in 1978-79 is available on request).

Applications were considered first by the Research Subcommittee (P. D. Foley, C. D. Fowle, R. Frank, D. N. Huntley, F. L. McEwen, G. R. Stephenson, D. W. Wilson, and C. R. Harris (Chairman)) and then by the Advisory Committee. Twenty proposals were accepted (Appendix II) valued at $446,300. Awards ranged in value from $1,100 to $170,000. All grants were awarded to universities (Guelph - 11, Western Ontario - 4, Waterloo -2, York, Carleton, Ottawa - 1 each).

Direction and progress of the research program was monitored by the Advisory Committee in several ways. Initially some applicants were asked to modify their proposals to better meet the research guidelines. Informal contacts between the research subcommittee and some recipients of grants were established. Two research seminars were held. The first, dealing with control of vertebrate pests, was held in November 1978. The second, relating to all other projects, was held in January, 1979. Recipients of grants discussed their research results at these meetings which were well attended by recipients of grants, Advisory Committee members, and many others interested in pesticide research and pest control. Each recipient of a grant provided the Advisory Committee with a summary of his results (Appendix III). Published research reports and theses relating to research supported by the Pesticides Advisory Committee are listed in Appendix IV.

Progress made in 1978-79 relative to the objectives of the program may be summarized as follows:

Objective 1: To find alternative pesticides for those deemed environmentally hazardous and thus restricted in use.

Environmental concerns have resulted in restrictions on the use of some pesticides in Ontario. In most instances alternative chemicals were available. In a few cases control measures were unsatisfactory or the alternative chemicals available presented their own special hazard, e.g. the high mammalian toxicity of parathion. In these instances the Advisory Committee has funded research aimed at developing satisfactory methods of chemical pest control. Two grants were awarded in 1978-79 totalling $83,200. Another project, begun in 1977-78, was completed.

Studies on the biology of important species of mosquitoes in southwestern Ontario were continued. In addition, base-line toxicity data were obtained for temephos using susceptible strains of several common species of mosquitoes. Subsequent tests on field-collected larvae indicated that there is no evidence of buildup of temephos resistance in southwestern Ontario. Several insecticides were evaluated as larvicides and/or adulticides - a number of organophosphorus (OP) insecticides were effective. Two new groups of insecticides - insect growth regulators and pyrethroids showed promise. The value of Blitz-Foggers(R) for backyard mosquito control was assessed with results indicating that mosquito activity could be reduced for relatively short periods (12)*. In other work on biting fly control the insect growth regulator, methoprene, and the OP insecticide, chlorpyrifos-methyl, showed promise in laboratory tests against blackfly larvae (8).

Termites are serious structural insect pests in many areas of the world and are becoming more common in Ontario. They have been controlled with persistent organochlorine (OC) insecticides, but these uses are being eliminated when possible. The development of alternative control programs will be dependent to a considerable extent on obtaining a better understanding of their life history under Ontario conditions. In 1978-79 observations were made on the behaviour of field dwelling termite colonies in three locations in southwestern Ontario. Information

* Numbers in brackets refer to Abstracts included in Appendix III.

was obtained on the proportion of castes within the colonies throughout the year, on numbers of winged individuals, and on reproduction (14).

The cabbage maggot is an important economic insect pest in Ontario. It developed resistance rapidly to the cyclodiene insecticides and recently OP insecticides currently recommended seem to be less effective. Growers are resorting to use of more adulticide sprays, often using parathion. A study was initiated to determine whether incorporation of different types of baits into the insecticide sprays would provide better adult control. Several insecticides were tested in the laboratory to determine direct contact toxicity to the flies and toxicity and persistence of insecticides and insecticide-bait combinations applied to plant foliage. The direct contact toxicity to flies of some pyrethroid insecticides was similar to that of parathion (16).

While environmental contamination resulting from agricultural use of mercurial compounds is minimal in Ontario when compared to industrial pollution, mercurial pesticides have been replaced when feasible. In late 1978 a study was initiated to evaluate the efficacy of several non-mercurial fungicides in controlling snow mold on fine turfgrass. Several experimental compounds showed promise under some conditions, but were less effective under other conditions. Fungicides containing mercury were the only compounds that gave consistently good control at all sites (21).

One of the few remaining uses of DDT is for bat control. Results of a study conducted during the summer of 1978 suggested that the primary means of bat control should involve sealing access holes to buildings used by bats rather than applying DDT. The latter sprayed on one colony of bats reduced but did not eliminate the population (6).

Objective 2: To determine potential environmental hazards with pesticides presently in use.

Nine grants totalling $71,500 were allocated to this objective. Results of two other studies begun in 1977-78 are included also in this report.

Restrictions on the use of OC insecticides are generally resulting in a slow decline in OC residues in the Ontario environment. One OC insecticide, endosulfan, is still used quite extensively. It is considered to be less persistent than other OC insecticides. However, recent studies indicate that endosulfan residues are present at relatively high levels in some organic soils in Ontario. Laboratory tests indicated that, in soil, while there are several metabolites, endosulfan sulfate will be the predominant residue. In aqueous medium endosulfan was converted to the diol → α-hydroxyether → endosulfan lactone. The latter disappeared rapidly in the aqueous medium. These laboratory results are probably a good indication of the fate of endosulfan in soil and streams in Ontario (23).

OP insecticides have been introduced as replacements for the OC insecticides. Earlier studies indicated that OP insecticide residues are not accumulating to any significant extent in mineral soils in Ontario, but they are present at quite high levels in organic soils used for vegetable production e.g. the Holland Marsh. These residues are largely the result of the widespread use of ethion to control the onion maggot. Tests conducted over two years indicate that, when applied at application rates suitable for onion maggot control, the carryover of residues of three other OP insecticides would be significantly less than that occurring with ethion (1).

Carbamate insecticides are recommended also for control of insects attacking vegetables grown on organic soils. A survey was conducted in the fall of 1977 to determine if residues of this group of insecticides are accumulating in organic soils. Some soils contained low levels of carbofuran but, in general, the carbamates do not appear to be accumulating in organic soils in southern Ontario (22). When compared to OP insecticides used to control soil insects in organic soils the order of persistence was ethion>chlorpyrifos>chlorfenvinphos>fonofos>carbofuran. (1, 22).

Further research on the pyrethroid insecticides was supported. Analytical methods were developed for determining the C-1 R and S isomers of permethrin and cypermethrin and their relative persistence in soil was determined under laboratory conditions. Another laboratory study indicated that the persistence of fenvalerate in mineral soil was concentration dependent (1). Still another laboratory study indicated that the degradation of pyrethroid insecticides in soil was primarily through microbial action (19). Field studies on the persistence of four pyrethroid insecticides in soil were completed. The insecticides dissipated from mineral soil within a year after treatment, but were more persistent in the organic soil (1).

In studies on herbicides, commercial formulations of aniline-based herbicides were examined for substituted azobenzene content. Studies were continued on the microbial transformation of chlorinated aniline residues in soil (3).

Organochlorine insecticides had the potential to cause drastic effects on non-target terrestrial and aquatic organisms. Less is known as to environmental side effects which other pesticides might cause and for several years the Pesticides Advisory Committee has been encouraging research in this area. Techniques for assessing specific effects of pesticides on soil processes are time-consuming and laborious. Development of a technique for assessing overall rather than specific effects of pesticide treatments on soil processes, such as litter decomposition, continues to show promise. Further work was continued on the development of the "litterbag" technique by testing decomposition rates of different leaves under a variety of conditions. To test the feasibility of using this technique to assess the effect of pesticides on decomposer organisms, a field experiment was set up using carbofuran. The results thus far suggest that the litterbag technique will be a practical approach to assessing pesticide effects on decomposer organisms in soil (18).

Several studies were conducted to assess potential side-effects of herbicides on non-target organisms. The behaviour of diquat in sediments was investigated, including adsorption/desorption phenomena, penetration into sediments, decomposition, transport, and "carrying capacity"of various sediment types. Based on the data generated, computer simulation studies were made which will be used to develop predictive models (11). The potential of diquat residues adsorbed by sediments to cause phytotoxicity was also investigated. In laboratory tests in a closed system diquat had some effects on growth of freshwater algae (2). Studies on the behavioural effects of sublethal doses of aquatic herbicides on the rheotropic response of rainbow trout were continued. Some herbicides, including 2,4-D butoxyethanol ester affected rheotropic response at concentrations equivalent to field application rates. At 2X the maximum field application level this herbicide was lethal to rainbow trout.

Investigation of the degree of pain and distress caused to vertebrate pests on exposure to pesticides used to control them was continued. Several vertebrate pesticides were tested using the laboratory rat and white carneau pigeon as test animals on the basis of clinical signs and behaviour during exposure to the pesticide. Electroencephalograms were recorded during exposure and terminally and behaviour and function of the animal was assessed prior to and when unconsciousness occurred. Emphasis was placed on animal response to Avitrol (R), anticoagulant agents, and Vacor(R) (15). In another study progress was made on development of a model for quantitative study of nerve growth with the objective of using this model to test the ability of pesticides to inhibit nerve growth (20).

Objective 3. To reduce total pesticide input into the environment.

The most practical solution to an environmental problem is to reduce or forbid use of a chemical which has, or may become a serious environmental contaminant. The pesticide problem is more complex - a pesticide is deliberately introduced into the environment to control a specific pest or pest complex. Control of pests attacking agricultural crops, forests, or man and his animals is essential. Current and future pest control programs are, and will be heavily dependent on the use of chemicals. However, it should be possible, through modification of these programs to use less pesticide more effectively. The Pesticides Advisory Committee considers this to be the major objective of the research program and supported six research projects valued at $291,600. in 1978-79. This included a grant of $60,000. given by the Ministry of the Environment to the University of Guelph to aid in establishment and operation of the Arboretum (10).

Pesticides are often applied as "insurance treatments", i.e. the grower is not sure that the pest will be present at a level high enough to cause serious damage, but cannot afford to take the risk that this will occur. Thus it is important to determine economic thresholds of damage below which pesticide application would be unnecessary.

Damage to alfalfa by the potato leafhopper has become more obvious in Ontario in recent years and chemical controls were recommended in 1978. However, there are no data on economic significance of this insect on alfalfa in Ontario. A study was initiated in 1978 to determine the effect of leafhoppers on quantity, quality and survival of alfalfa. Preliminary results indicated that in untreated fields losses in dry weight of alfalfa varied from 6.7 to 30% and that chemical treatments on both first- and second-cuts were cost effective (5). Crop loss estimates were obtained for onions grown with and without insecticide treatment. In the absence of insecticide treatment at the Thedford Marsh crop loss due to onion maggot attack was $44, 862, 845, and 401/acre for Dutch Sets, pickling onions, sets from seed, and dry onions, respectively. (2.8 - 30.8% damage). With insecticide treatment onion maggot damage was <1% in all cases (17). In a study on the extent and nature of bird damage to corn in Ontario, 1977 survey results indicated that total losses of grain corn to birds were in the order of 39,200 tonnes, which was equivalent to a 0.7% reduction in yield. Damage was much higher in some areas than others with the highest percentage reductions in yield (6%) occurring in Northumberland county. Secondary effects of bird damage on feed quality and quantity by development of molds and mycotoxins were studied also (9).

Development of effective pest monitoring techniques would result in a marked reduction in pesticide use, i.e. with pesticide applications timed to appearance of the pest there would be no requirement for "insurance" applications. The Advisory Committee supported several projects in 1978-79 which involved biological studies leading to development of monitoring programs. Work was continued on development of an onion maggot monitoring program at the Keswick Marsh and another study was initiated at the Thedford Marsh. In both instances programs developed for monitoring for the appearance of onion maggot flies resulted in as, or more effective onion maggot control with fewer spray applications (12, 17). Development of a similar approach toward reducing the number of fungicide sprays applied to carrots and onions has been supported for several years. Earlier studies indicated that fungicide sprays are required on onions when weather conditions (rain) are favourable for development of fungal infection. During showery weather leaf wetness is usually intermittent. Laboratory studies were conducted to obtain a better understanding of intermittent wetness as it related to the spray scheme. Refined spray-timing schemes were compared in field tests at the Holland Marsh with a regular spray schedule. Adoption of a higher economic threshold prior to spraying resulted in an 80% reduction in sprays along with good disease control (7). With vertebrate pests, biological studies of blackbirds also were continued to provide background information necessary if population management is to be implemented. The 1978 field program encompassed an assessment of red-winged blackbird productivity in marsh and upland habitats, a survey of the Matchedash Bay roost and flyway populations, a bird marking program to monitor movement patterns, and an investigation of feeding ecology to relate corn damage to patterns of alternate food (weed seed) abundance within specific sites. Control studies were limited to further investigation of the effectiveness of Avitrol(R) which previous research had shown results in an economic reduction in bird damage in some treated fields. Avitrol use in 1978 was very limited but growers using it generally indicated that they were satisfied with the performance of the chemical (9).

Pesticide application techniques are crude and only a small fraction of the pesticide applied actually reaches the target. More efficient application techniques would result in better pest control with less environmental contamination. No research on application techniques was funded during 1978-79. However, it was gratifying to note that research on development of an electrostatic sprayer, which was funded over a period of five years by the Advisory Committee, was recently supported by Agriculture Canada through a research contract in excess of $50,000.

Alternative non-chemical methods of control may represent the ideal approach to reducing pesticide input into the environment in a few instances. Research on development of an integrated control technique for the onion maggot was continued in 1978-79. This procedure involves the use of an insecticide for control of first generation maggot, followed by releases of sterilized adults for second and third generation control. In a large-scale field test the release of sterile flies resulted in a significant reduction in fertility of native females (12).

ASSESSMENT

As reported earlier (OPAC, 1978) many of the pest control problems which arose when use of the OC insecticides was restricted a decade ago have been resolved. Results of research conducted on bat control during the past year suggest that still another use of DDT, while it might not be completely eliminated, could be reduced through use of another management technique. In the case of biting flies good progress is being made on development of alternative, less environmentally hazardous chemicals for mosquito and black fly control. Development of an integrated technique for management of biting flies remains very much a long-term goal. Some problems remain. The biology of termites in Ontario is poorly understood and there are few effective insecticides. The chances of eliminating the mercurial fungicides for control of diseases on fine turf grass, e.g. golf courses, do not currently appear promising and, as mentioned earlier, the introduction of some of the newer pesticides, while reducing one environmental hazard, has created others, e.g. the high mammalian toxicity of insecticides such as parathion. To achieve effective control of insect pests, some of which are developing a low level of resistance to OP insecticides, growers must use these insecticides more frequently and at higher rates of application. Research on development of less hazardous chemicals and better methods of application for control of pests such as the onion and cabbage maggots is essential.

Under the second objective of determining potential environmental hazards with pesticides presently in use, good progress has been made in defining the behaviour and fate of pesticides, especially insecticides, in the environment. OC insecticide residues are declining in agricultural soils in Ontario, residues of OP insecticides are not accumulating in mineral soils to any significant extent, nor are carbamate insecticides building up in organic soils. The results of studies conducted in 1978-79 and in previous years suggest that any

side effects of pesticides currently in use on non-target soil and aquatic organisms will be transitory. As far as can be determined with techniques currently available, the common vertebrate pesticides act within acceptable limits of pain and distress when used in control programs. There are two areas meriting concern. Organic soils are important agriculturally in Ontario, They are farmed extensively and the value of vegetables produced in the various "marshes" is about $30,000,000/year. The extent of pesticide use on these marshes, the residues being detected in soil, water and air, and the exposure of workers to these residues is of major concern. Good progress is being made in defining the residue picture in these organic soil areas, and in developing less persistent insecticides for control of the major insect pests. Similarly, more research is justified on herbicide persistence and behaviour, particularly in the aquatic environment. Laboratory studies in 1978-79 indicated that, under laboratory conditions some of these pesticides could have undesirable side effects. While laboratory studies in a closed system do not necessarily indicate what would happen under natural conditions, they do suggest that further research would be desirable.

As noted earlier the Pesticides Advisory Committee feels that priority should be assigned to the third goal of reducing pesticide input into the environment while still achieving as, or more effective pest control. Good progress was made in developing crop loss data and/or monitoring techniques for key insect and avian pests and plant diseases. The program on development of an integrated control technique for the onion maggot continues to show promise but the difficulties being encountered with the sterile male technique demonstrate the complexity of devising this type of program.

The Pesticides Advisory Committee is pleased with the research progress made in 1978-79 and recommends continuation of the program. Part of the success of the program is due to the fact that it has been deliberately kept small allowing committee members, all of whom have other full-time responsibilities to administer it with a minimum of effort. The Committee feels that this approach should be maintained. In doing so, it recognizes that with the limited funds available, the program can be expected only to act as a catalyst, in stimulating research in the broad areas indicated in the guidelines, for which there is still an urgent requirement.

IV. REFERENCES CITED

Ontario Pesticides Advisory Committee. 1974. An assessment of research projects funded by the Ministry of the Environment through the Ontario Pesticides Advisory Committee, 1973-74. 33 p.

1975. An assessment of research projects funded by the Ministry of the Environment through the Ontario Pesticides Advisory Committee, 1974-75. 36 p.

1976. An assessment of research projects funded by the Ministry of the Environment through the Ontario Pesticides Advisory Committee, 1975-76. 42 p.

1977. An assessment of research projects funded by the Ministry of the Environment through the Ontario Pesticides Advisory Committee, 1976-77. 40 p.

1978. An assessment of research projects funded by the Ministry of the Environment through the Ontario Pesticides Advisory Comittee, 1977-78. 39 p.

APPENDIX I. Format of advertisement inviting applications for research support from the Ontario Pesticides Advisory Committee, 1978-79.

January 1978.

APPLICATION FOR RESEARCH SUPPORT

The Ontario Ministry of the Environment has a limited amount of funds available for 1978 to sponsor research aimed at: 1) determining potential environmental hazards associated with pesticides currently in use; 2) developing alternative pesticides for those deemed environmentally hazardous; and 3) developing alternative approaches to pest control in order to reduce total pesticide input into the environment. Preference is usually given to proposals yielding results in a relatively short time with funds being committed on a yearly basis. Research should be in the context of normal use patterns.

The Ministry invites research proposals in the following areas:

1. Economics of pest control including economic threshold levels of pests.

2. Studies leading to registration of environmentally acceptable pesticides.

3. Reduction of pesticide use through development of effective pest monitoring techniques; alternative integrated or non-chemical methods of control; or improved application techniques.

4. Studies on the fate and biological significance of pesticides in the environment with particular reference to pesticides widely used in Ontario.

5. Development of information on time which should elapse between dates of treatment and re-entry into treated areas, and on human exposure to pesticides.

APPLICATION PROCEDURE

Research proposals should be submitted to:

The Chairman, Pesticides Advisory Committee
Ontario Ministry of the Environment
5th floor, Mowat Block
Queen's Park
TORONTO, Ontario M7A 1A2

Applications should include the following:

1. Title of project
2. Name, address and affiliation of applicant(s)
3. Discussion of problem (Applicants applying for continuation of a grant should include a summary of previous progress)
4. Clear statement of objective(s)
5. Plan for program
6. Facilities available
7. Budget - categorize costs as: Personnel - full time and part time, equipment, supplies, overhead costs, other
8. Listing of current projects and other sources of funding
9. Curriculum vitae on principal investigator(s) (if not already on file with the Pesticides Advisory Committee).

Applications should be received by February 10, 1978.

APPENDIX II. Research Projects Supported by the Ontario Pesticides Advisory Committee, 1978-79

No.	Applicant	Location	Project Title	Amount Granted
1.	Chapman, R. A. Svec, H. J. Spencer, E. Y.	University of Western Ontario	Activity and persistence of some organophosphorus, carbamate and pyrethroid insecticides in soil	$ 9,700.
2.	Colman, B.	York University	The dynamics and persistence of the herbicide diquat in the freshwater environment	7,600.
3.	Corke, C. T. Bunce, N. J.	University of Guelph	Biological production of biphenyls and azobenzenes from chlorinated aniline residues from certain herbicides	5,000.
4.	Dodson, J. J. Mayfield, C. I.	University of Waterloo	The behavioral effects of sublethal doses of aquatic herbicides on the rheotropic response of rainbow trout	8,900.
5.	Ellis, C. R.	University of Guelph	The economic significance of potato leafhoppers in new seedings of alfalfa	9,900.
6.	Fenton, M. B.	Carleton University	A study of different methods of controlling bats	9,500.
7.	Gillespie, T. J. Sutton, J. C.	University of Guelph	Reduction of fungicide usage on vegetable crops by timing fungicide applications according to weather data	10,300.
8.	Kaushik, N. K.	University of Guelph	Effects of insect growth regulators on emergence of black fly larvae and on non-target aquatic invertebrates	9,200.
9.	Kannenberg, L. W. Gilbert, F. F. Busch, L. V.	University of Guelph	Vertebrate pests in Ontario, their importance, ecology and control	170,000.

APPENDIX II cont'd.....

No.	Applicant	Location	Project Title	Amount Granted
10.	Lowe, S. B.	University of Guelph	A study of land form alterations and establishment of plant species	$ 60,000.
11.	Mayfield, C. I.	University of Waterloo	Diquat in aquatic systems	7,200.
12.	McEwen, F. L.	University of Guelph	Optimum methods for sterile male control of the onion maggot Hylemya antiqua Meigen	32,400.
13.	McEwen, F. L. Surgeoner, G. A.	University of Guelph	The biology and control of mosquitoes and other biting flies in Ontario	50,000.
14.	Pengelly, D. H.	University of Guelph	The ecology of subterranean termites in Ontario	7,500.
15.	Rowsell, H. C.	University of Ottawa	Assessment of pain and distress caused by vertebrate pesticides	12,000
16.	Sears, M. K.	University of Guelph	Baited insecticides for control of adult cabbage maggots on rutabagas	7,000
17.	Svec, H. J. Miles, J. R. W. Harris, C. R.	University of Western Ontario	Development of effective monitoring techniques and control programs for insect pests attacking vegetables grown in the Thedford Marsh	9,000.
18.	Tomlin, A. D.	University of Western Ontario	Feasibility of using the litterbag technique as an index of the environmental impact of soil insecticides on the soil fauna	11,000.
19.	Tu, C. M. Chapman, R. A. Spencer, E. Y.	University of Western Ontario	Microbial degradation of pyrethroid insecticides in soil	9,000.
20.	Turner, C. J.	University of Guelph	The effect of pesticides upon the growth of nerve endings	1,100.
			TOTAL	446,300.

APPENDIX III. Progress reports (Abstracts) on projects funded by the Ontario Pesticides Advisory Committee, 1978-79.

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1. Chapman, R. A., Svec, H. J., and Spencer, E. Y. - Activity and persistence of some organophosphorus, carbamate and pyrethroid insecticides in soil.

Field microplot studies set up in 1977 to examine the uptake of furrow granular treatments of insecticides by onions from organic soil and the carryover of the insecticides in the soil to the following years were continued. Residues in the soil after the first growing season were 4.36, 1.10, 1.09, 1.65 and <0.02 ppm for ethion, fonofos, chlorfenvinphos, chlorpyrifos and carbofuran respectively. These had decreased to 1.85, 0.59, 0.77, 0.84 and <0.02 ppm by the following spring and changed to 3.06, 0.42, 0.90, 1.07 and <0.02 following the second growing season. The experiment is scheduled to run for one more year.

Analytical methods were developed for determining the C-1 R/S ratios in residual amounts of permethrin and cypermethrin to the 0.05 ppm level in soil. Analyses of this ratio in samples from a previously described laboratory persistence study shows that the loss of biological activity is not due to the preferential degradation of the more insecticidally active C-1 R isomers. Further laboratory study has shown that the persistence of fenvalerate in sand at 0.5 and 10 ppm is concentration dependent but largely independent of moisture concentration at 0.5 and 5%. This provides a rational explanation for differences in soil persistence previously observed between laboratory and field experiments which involved differences in initial residues of this size.

Field studies on the persistence of the four pyrethroids, permethrin, cypermethrin, fenpropanate and fenvalerate incorporated into mineral and organic soils were completed. Cypermethrin and fenvalerate in muck were the only soil-insecticide combinations to show persistence at >0.01 ppm into the second year from the 4 oz/acre application. Field studies were also carried out on the persistence and migration of a soil surface application of the four materials at the same rate. No downward migration of the insecticides from the top 5 cm was observed. Results to date indicate the persistence is similar to the previous study involving incorporated insecticide.

2. Colman, B., and Birmingham, B.C. - The dynamics and persistence of the herbicide diquat in the freshwater environment.

The bipyridilium herbicide diquat (Reglone A$^{(R)}$) is registered for control of mixed submergent aquatics at an application rate of 2 gal. commercial product per acre (0.25 - 1.5 ppm depending on water depth). Diquat is very water soluble (70% w/v) and dissipates rapidly in natural aquatic systems. Due to its cationic nature diquat is readily adsorbed by clay minerals, organic soils, higher plants, and decayed organic matter. In its adsorbed state, diquat is considered "inactivated" and "immobile" because it is apparently unavailable as a herbicide and leaching is negligible.

Most of the diquat administered to water ultimately accumulates in the sediment either directly or after adsorption to particulate matter, aquatic plants or animals which subsequently decay and release diquat at the water-hydrosoil-sediment interface. Diquat residues have been shown to accumulate and persist intact in aquatic sediments for long periods of time.

We have investigated the adsorption and desorption of Reglone A(R) to axenic cultures of freshwater algae and a greenhouse soil-sand mixture, singly and in combination to examine the potential for phytoxicity of diquat residues in aquatic sediments.

The adsorption capacity of the algae for Reglone A was as follows:

	mg Reglone/g dry wt
Chlorella vulgaris (unicellular green alga)	5.0
Navicula pelliculosa (diatom)	4.6
Anabaena flos-aquae (blue green alga)	1.0
Spirogyra-Cladophora mixture (filamentous green algae)	4.0

Five molar ammonium chloride could desorb 40% to 70% of the Reglone adsorbed to these algae.

The greenhouse soil-sand mixture used in these studies contained 22.7% organic matter as measured by ignition loss. The maximum adsorption capacity of this soil mixture was 2.6 mg Reglone/g dry wt. Using 5 M ammonium chloride, 1.8 mg Reglone/g dry wt. (70%) could be desorbed.

In short term studies of up to 2 hours Reglone at concentrations up to 8 ppm had no effect on the photosynthesis of *Chlorella* as measured by O_2-evolution using an O_2 electrode. Long term growth studies also showed that *Chlorella* was unaffected by Reglone concentrations up to 3 ppm. This suggests that while *Chlorella* can clearly bind diquat, the diquat does not enter the cell.

In contrast, the growth of the diatom *Navicula pelliculosa* was inhibited by Reglone concentrations exceeding 0.3 ppm and the growth of the bluegreen algae *Anabaena flos-aquae* and *Anacystis nidulans* was inhibited by Reglone concentrations exceeding 0.03 ppm. The presence of the soil mixture (10 g per 50 ml) completely removed the inhibitory effect of Reglone over the concentration range 0.03 to 3 ppm.

Experiments were performed to evaluate the residual phytotoxicity of Reglone bound to sediments. Reglone was added to flasks containing 50 ml dechlorinated tap water and 10 g soil-sand mixture so that the final concentrations in water were 0, 0.3, 3.3, 33.4 and 334 ppm. After nine days, diquat remaining in the water, diquat bound to the soil and the amount of diquat that could be desorbed by 5 M ammonium chloride was measured. The fraction of diquat desorbed was considered to be potentially phytotoxic. The water fraction of the remaining flasks was decanted, the soil washed, and replaced with tap water.

The flasks were then inoculated with either *Anabaena flos-aquae* or the duckweed *Lemna* for bioassay of the potentially phytotoxic diquat. No effects on the growth of *Anabaena* or *Lemna* were observed in the 0.3 and 3.3 ppm treatments. Definite growth inhibition (>50%) was observed in the 33 ppm treatment and growth was completely inhibited in the 334 ppm treatment. The complete cessation of growth in the 334 ppm treatment can be attributed in part to the release of diquat from the soil, 7.3 ppm being measured in the water fraction at the termination of the experiment.

The results obtained from these experiments suggest that as the amount of diquat adsorbed by this particular soil system approaches about 10% (0.165 mg Reglone/g dry wt in the 33.4 ppm treatment) of the maximum adsorption capacity (1.43 mg Reglone/g dry wt in this case), residual phytotoxicity becomes apparent in this closed system. In open systems such as lakes and rivers, currents, solifluction and sedimentation processes as well as the composition of the sediments themselves would be expected to considerably attenuate diquat buildup. However given the literature reports of high recovery of applied bipyridyl herbicides in pond and reservoir sediments, some knowledge of the adsorption/desorption properties of the bottom sediments of natural bodies of water should be obtained before long term treatment with diquat is instigated.

3. Corke, C. T. and Bunce, N. J. - Biological production of biphenyls and azobenzenes from chlorinated aniline residues from certain herbicides.

This past year we have examined commercial formulations of aniline-based herbicides for their content of substituted azobenzenes. One of the azo-compounds (3,3'4,4'-tetrachloroazobenzene-TCAB) has been implicated in severe outbreaks of chloracne in workers handling anilines. Moreover, TCAB has been shown to be carcinogenic and mutagenic. Samples of herbicides were eluted over alumina and the presence of TCAB was determined by gas liquid chromatography, absorption spectra and confirmed by mass spectometry. The origin of the azocompound is probably from the parent 3,4-dichloroaniline used in the synthesis of this herbicide. Industrial quality control measures in the selection of better sources of 3,4-dichloroaniline should be recommended to eliminate this undesirable contaminant.

We have continued our studies on microbial transformations of chlorinated aniline residues and have included chlorinated nitro-compounds which are also released during the degradation of certain pesticides added to soil. The compound 3,4-dichloroaniline is transformed in the presence of nitrate-nitrogen by soil or sewage organisms (which possess a nitrate reducing enzyme) to a variety of higher molecular weight compounds. The aniline is converted to a reactive diazonium ion which leads to the formation of dichloro-biphenyl, trichlorobiphenyl and tetrachlorobiphenyls (2 isomers), tetrachloro-azobenzene, 3,3',4,4' tetrachlorodiphenylamine, and 1,3-bis (3,4-dichlorophenyl) triazene. The bacteria which convert anilines are capable also of transforming 1,2 dichloro-4-nitrobenzene by a series of reductions presumably involving 1,2-dichloro-4-nitrosobenzene, 1,2-dichlorophenyl-4-hydroxylamine and finally to 3,4-dichloroaniline. The metabolites tetrachlorobiphenyl, azobenzene and bis-triazene originate from the 3,4-dichloroaniline. An additional compound 3,3',4,4'-tetrachloroazoxybenzene is formed from the nitroso- and hydroxylamine-derivatives. Bacillus megaterium is a representative soil bacterium which cannot transform 3,4-dichloroaniline to any of the mentioned metabolites. This bacterium however does reduce nitrobenzenes to anilines, and during this reduction 3,3',4,4'-dichloroazoxybenzene was also formed. In addition the compound 3,3',4,4'-tetrachloroazobenzene was found (1.46%), probably produced by reduction of the azoxycompound.

4. Dodson, J. J. and Mayfield, C. I. - The behavioral effects of sublethal doses of aquatic herbicides on the rheotropic response of rainbow trout.

The rheotropic response of yearling rainbow trout to a water current simulated by moving a striped background past the fish was observed following 24 hour exposures to field application concentrations and greater of the aquatic herbicides 2,4-D butoxyethanolester, its commercial formulation Aqua-Kleen; terbutryn and its commercial formulation Clarosan, and the experimental herbicide EL-171 (Elanco Products Division, Eli Lilly and Company (Canada) Ltd.) and its liquid and granular formulations.

Toxicological modification of rheotropism occurred at concentrations of Aqua-Kleen (2 to 7 ppm AI) equivalent to field application rates that in nature would lead to an increased incidence of downstream movement. As concentrations approached lethal levels, trout began to exhibit comatose-like behavior characterized by little or no attempt to avoid capture. Aqua-Kleen was lethal to rainbow trout at concentrations approximately equal to twice the suggested maximum field application levels. Herbicide residue analysis of fish tissue and water samples revealed that the ester was taken up rapidly by fish and hydrolysed to 2,4-D acid that was subsequently secreted back into the water.

Yearling trout exposed to 0.0 (control),0.05, 0.1, 0.2, 0.3, 0.4, 0.5 and 1.0 ppm (AI) Clarosan and terbutryn exhibited decreasing frequencies of positive rheotaxis and increasing frequencies of negative rheotaxis with increasing herbicide concentration, behavior that in nature would lead to increased downstream movement. Fish exhibited comatose-like behavior as concentrations approached lethal levels and developed severely bloated bellies. The lowest concentration of Clarosan causing mortality was 4 ppm. Herbicide residue analysis is underway.

Yearling trout exposed to 0.0 (control), 0.05, 0.1, 0.2, 0.3, 0.4 and 0.5 ppm (AI) of EL-171 exhibited no toxicological modification of rheotropism. Lethal levels are presently being established and the herbicide residue analysis will be conducted by Elanco.

The rheotropic response of trout exposed to glyphosate and its formulation Roundup is presently under investigation.

5. Ellis, C. R. and Morris, G. W. - The economic significance of potato leafhoppers in new seedings of alfalfa.

The potato leafhopper is a native pest of North America which sucks nutrient from alfalfa causing yellowing and stunting in Ontario. This damage has become more important in recent years because of the value of quality forage. Although chemical controls were recommended for the first time in 1978, there were no data on the economic significance of this insect on alfalfa in Ontario. The specific objective of this project was to determine the effect of leafhoppers on the quantity (dry weight) and quality (protein content) of newly seeded alfalfa the year of attack and on winter survival, yield and quality the second year of production. This data will determine the economic significance of leafhoppers on alfalfa and determine under what circumstances insecticides should be applied.

The main research approach in 1978 was to work in commercial fields with farm cooperators. A total of seven fields of spring-seeded alfalfa were selected from Welland, Woodstock, Brantford and Arkell. In each field, a non-sprayed check area was compared with areas treated with dimethoate and methoxychlor as recommended by OMAF for leafhopper control on alfalfa. The leafhopper populations, forage height and protein content were sampled throughout the season and dry weight yield and protein were determined at harvest. This data for one year from five fields showed that losses in dry weight varied from 6.7 to 30% in check areas and that chemical treatments on both the first and second cuts were cost-effective. A follow-up study on winter survival in each plot of each field is in progress and, as well, the dry weight yield and protein content will be recorded from these plots next year to determine the long-term impact of leafhopper damage.

Field cages containing 0-4 leafhoppers/plant were established on individual plants 10, 13, 15 or 20 cm high to determine the relationship between leafhopper numbers, stage of plant growth and damage. Two hundred and forty cages were used to make 12 replicates of each treatment. The protein analysis has not been completed and no conclusions are possible at this time. Each caged plant was marked and a study of winter survival is in progress. Dry weight and protein will be determined on these plants next year.

6. Fenton, M. B., Barclay, R. M. R., and Thomas D. W. - A study of different methods for controlling bats.

This report documents the effectiveness of a variety of control measures used on colonies of big and little brown bats. Incidences of permanent colonies were also determined and it was found that this was low in urban areas but considerably higher in rural sectors. Sealing the entrance holes used by bats was the most effective means of control, eliminating the whole colony in two of four cases and reducing population levels in the other two by no less than 55 per cent. DDT sprayed on one colony reduced, but did not eliminate the population and evidence from past spraying indicated that repeat applications are often necessary. Because the peak in bat/human contacts and pesticide applications occurs in August and September, a time of transient bat behaviour, and many contacts are the result of single animals, the majority of previous DDT sprayings have been unwarranted. In the future, the primary means of bat control should involve sealing the holes used by the bats to gain access to buildings. As well further public education about the problem should help reduce the number of requests for extermination.

7. Gillespie, T. J., Sutton, J. C., and P. A. Dzikowski. - Reduction of fungicide usage on vegetable crops by timing fungicide applications according to weather data.

A weather-timed spray scheme developed in previous years specifies that a fungicide is required before periods favourable for infection of onion leaves by Botrytis squamosa (i.e. leaf wetness duration $\geq$16 h at $\geq$15 C). Rain is normally required for wetness to persist more than 12 h. During showery weather, however, wetness is often intermittent. To improve our understanding of intermittent wetness as it relates to the spray scheme and irrigation practices, relevant studies of interrupted infection periods

were conducted in a controlled environment (Table 1).

INCUBATION CONDITIONS AT 12C			% LEAF AREA WITH BLIGHT	% MAXIMUM INFECTION
Wet	Dry	Wet		
12h	0h	0h	4.7*	26
20h	0h	0h	17.8	100
4h	4h	20h	10.2	57
8h	4h	20h	3.6*	20
12h	4h	20h	5.1*	29

*VALUES NOT SIGNIFICANTLY DIFFERENT AT 5% LEVEL OF CONFIDENCE

When the initial wet period was 8 to 12 h, a subsequent dry period of 4 h terminated infection, and disease did not increase even after a further 20 h wetness. In contrast, the infection process was not terminated when the initial wet period was only 4 h. In these experiments few spores had germinated after 4 h, but most had germinated after 8 to 12 h of wetness. Thus the non-germinated spores survived the dry period but germinated spores desiccated and died during the 4 h dry period. One hour of dryness was not sufficient to kill germinated spores.

Refined spray-timing schemes with two initial starting criteria were compared with a regular spray schedule at the Holland-Bradford Marsh (Table 2).

PROGRAM	STARTING POINT (Lesions/Leaf)	NO. OF SPRAYS (Bravo 5F)	% DISEASE on Aug. 29	YIELD GRADE A ONIONS (>4.5 cm) 50 lb bags/acre	Tonnes/ha
No Spray	---	0	11.4	825	48.0
Regular	1	5	1.5	738	41.3
Early-timed	1	4	1.7	768	43.0
Late-timed	10	1	2.5	923	51.7

Weather conditions were infrequently favourable for blight and the criterion for the initial spray in the late-timed scheme was not realized However, one spray was applied at lodging as required for controlling "late season" diseases. An 80% reduction in sprays along with good disease control resulted from use of the higher starting criterion. The yields from sprayed and non-sprayed treatments were alike, indicating that the economic threshold for Botrytis blight lies above 11% diseased tissue near harvest.

8. Kausik, N. K. and C. S. Rodrigues. - Effects of Insect Growth Regulators on Emergence of Black Fly Larvae and on Non-Target Aquatic Invertebrates.

The objective of this project was to develop safe, efficacious and economical methods for the chemical control of black flies. Research during the year involved the assay of a variety of insect growth regulators as well as that of new formulations of conventional larvicides under laboratory conditions. The research was conducted at the New York State Science Service's Biological Field Station in Cambridge, New York. This laboratory is provided

with numerous flowing water troughs which simulate natural stream conditions.

The juvenile hormone analogue methoprene (Altosid(R) PS 10) was tested against Simulium vittatum late instar larvae at concentrations ranging from 0.0038 to 1.0 ppm for 5 minutes exposure at a water temperature of 13°C. At 1 ppm the reduction in eclosion based on pupal mortality was 76.4%. Under similar conditions the urea analogue, Bay SIR 8514 at 1 ppm for 5 minutes resulted in only 22.6% mortality of late instar larvae. In another trial with Bay SIR 8514, S. vittatum late instars were exposed for 15 minutes at 13°C water temperature to concentrations ranging from 0.08 ppm to 20.0 ppm. At 0.08 ppm the mortality was 18.8%, at 6.7 ppm it was 64.0% and at 20 ppm the mortality was 96.4%.

Diflubenzuron (Dimilin(R) 25% W.P.) was tested against predominantly S. vittatum larvae at concentrations ranging from 0.2 ppm to 20.0 ppm for 15 minutes exposure at a water temperature of 12°C. At 0.2 ppm the mortality was 26.2%, at 6.7 ppm it was 89.1% and at 20 ppm it was 96.0%.

The efficacy of eight different microencapsulated formulations of chlorpyrifos-methyl (Reldan(R)) was determined against late instar S. vittatum. These formulations were specifically designed to reduce non-target effects. The active ingredient is enclosed in water insoluble micro-capsules with toxicity depending on the ingestion of these capsules by the filter feeding black fly larvae. A mortality of 98.6% was produced by treatment with one of the formulations at 0.055 ppm for 10 minutes at 13°C water temperature. The eight formulations were compared with each other by the treatment of S. vittatum larvae at a dosage rate of 0.005 ppm for 10 minutes. Further laboratory assays were also carried out on the more promising formulations.

Under the conditions tested, methoprene and chlorpyrifos-methyl gave promising results. No tests against non-target organisms have yet been done.

9. Kannenburg, L.W., Gilbert, F. F., and Busch, L. V. - Vertebrate pests, their importance, ecology, and control.

Research team at the University of Guelph involved:

Prof. R. J. Brooks	- Dept. of Zoology
Prof. L. V. Busch	- Dept. of Environmental Biology
Prof. F. F. Gilbert	- Dept. of Zoology
Prof. D. E. Joyner	- Dept. of Zoology
Prof. L. W. Kannenberg	- Dept. of Crop Science
Research Associate J. Somers	- Dept. of Zoology
Prof. J. C. Sutton	- Dept. of Environmental Biology
Research Associate B. M. J. Tyler	- Dept. of Crop Science

During the 1978 research year, collection of data and analyses of the extent and nature of bird damage in corn were continued. Biological studies of blackbirds also were continued and expanded to provide the background information necessary if population management is to be implemented. The effect of Avitrol treatment on bird damage in treated and nearby untreated fields was compared, although the study was limited because only a few farmers had Avitrol applied to their corn fields in 1978.

I. EXTENT AND NATURE OF BIRD DAMAGE

Type, Extent and General Level of Damage, and Problem Locations in Ontario

Analysis of the 1977 general survey data was completed in 1978. On a grain corn basis, the total losses to birds in Ontario were in the order of 39,200 tonnes, which is equivalent to a 0.7% reduction in yield. The counties that sustained the highest percentage reductions in yield were Northumberland (6.0%), Prince Edward (2.8%), Hastings (3.9%), Simcoe (1.2%), Ottawa-Carleton (2.0%), Grenville (0.8%), Russell (1.1%), Dundas (0.9%), Essex (0.9%). Kent (0.9%), and Peel (0.8%). Maximum individual field losses observed in the general survey occurred in Northumberland (830 kg/h), Kent (380 kg/h), Lennox-Addington (350 kg/h), and Simcoe (410 kg/h) counties.

A 1978 survey of Simcoe County "hot spot" fields that had been surveyed previously in 1976 indicated that losses were again substantial in these areas with some fields having as much as 98% of the ears damaged. This information in conjunction with communiques from O.M.A.F. personnel indicate that blackbirds continue to be a severe pest in field corn.

Grain loss during storage is a concern to most cooperators who use corn cribs. The losses to birds are currently being estimated for several cribs. A letter survey in 1978 indicated that losses to birds in fields of small grains are a concern to many growers in Ontario including some as far north as Kenora and Rainy River. Bird depredation begins when the grain is in the milk stage and may continue until the crop is harvested.

Secondary Effects of Bird Damage on Feed Quality and Quantity - Molds and Mycotoxins

Relationships of primary injury to ears of corn by red-winged blackbirds to secondary injury associated with fungal colonization of the remaining kernels were studied in plots at two locations in Simcoe County. Fungal colonization, mycotoxin accumulation, and protein content were compared in ears injured by birds, in ears given simulated bird-injury, and in non-injured ears. Injury by birds was simulated in intact ears with an instrument comprised of a piece of wood (2 x 4 x 20 cm) with the pointed ends of six 3-cm nails projecting through one side at one end. When the instrument was drawn manually over the ear, husks were shredded and kernels injured similarly to damage produced by birds. The injury was inflicted at about the same time as natural injury by birds. Undamaged ears and those given simulated bird-injury were protected with nylon mesh caps. Weather factors in the plots were monitored.

Ears from each treatment were harvested at biweekly intervals from the time of injury until late October. Estimations were made of kernel moisture, percentage kernels injured, percentage colonization of non-injured kernels, zearalenone content, and protein content. Fungi colonizing kernels were identified.

Fungal colonization in non-injured ears was slight, but progressed extensively in bird-injured ears during September and October. Colonization in ears given simulated injury was less extensive than in ears injured by birds. The mechanism of predisposition to mouldiness of maize after bird damage is under study. The dominant fungi on non-injured kernels of injured

ears were Fusarium graminearum, F. moniliforme, and Trichoderma spp.

II. BLACKBIRD BIOLOGY

Following the completion of objective assessments of the efficacy of Avitrol and Mesurol for the protection of field corn from depredating blackbirds, the Zoology department elected to concentrate on ecological studies of red-winged blackbirds (Agelaius phoeniceus) in 1978. Continuation and expansion of projects initiated in 1977 in Tay Township, Simcoe Co., on the relationship of blackbirds from the Matchedash Bay roost to adjacent agricultural areas was necessary if population manipulation is to become a management option in this and/or other areas of the province. Consequently, the 1978 field effort encompassed an assessment of red-winged blackbird productivity in marsh and upland habitats, a survey of the Matchedash Bay roost and flyway populations, a bird marking program to monitor movement patterns, and an investigation of feeding ecology to relate corn damage to patterns of alternate food (weed seed) abundance within specific sites.

Red-winged Blackbird Reproduction

A two-year study to compare and contrast the reproductive strategies of red-winged blackbirds nesting in marsh versus upland habitat was completed in 1978. Preliminary analysis of nesting data suggests that the cattail marsh (Typha sp.) produced about 3 times the fledglings per unit area compared to nearby upland habitats (15.6/ha vs 5.4/ha, respectively). Nesting densities of 12.8/ha in marsh compared to 3.8/ha in upland areas followed a similar pattern when averaged over both years. However, the number of nests per hectare decreased by 43% in marsh habitat and by 23% in upland areas in 1978. A dramatic shift in the percentage of successful nests evident in 1978 was primarily due to decreases and increases in predation of nests in marsh and upland habitats, respectively. Consequently, the fledging rate in marsh habitat was relatively stable between years (14.8/ha, 1977; 16.2/ha, 1978). However, the number of young produced in upland areas declined by over 50% (7.2/ha, 1977; 3.5/ha, 1978) because of the decrease in nest density and the concurrent increase in predation. Explanation of these observations remains unlcear and awaits more detailed analysis of data, but may have been related to changes in water levels in the marsh areas between years.

Nesting densities and productivity also varied among plots within each generalized habitat type in both 1977 and 1978. For example, ditches lined with cattail stands in upland plots had higher nesting densities than did sites lacking water and cattails. Nest densities in marsh plots varied due to the water depth, the degree of water interspersion, and the extent of cattail clumping. Therefore, classification of optimal and sub-optimal habitats within seemingly homogeneous tracts of upland and marsh areas is a prerequisite for the assignment of average reproductive values to large tracts of land. This would then allow the prediction of potential blackbird output based solely on prenesting surveys of habitat composition.

Roost Population and Flyway Survey

Monitoring of roosts in north Simcoe Co. in 1978 was concentrated at Matchedash Bay (1.8 km north of Coldwater) because of the marsh's importance in relation to the productivity and feeding ecology studies and because of

limitations in manpower and time budgets.

The mean roost population was estimated at 90,000 blackbirds (cf. 107,000 in 1977) based on nine evening counts for each of four associated flyways from 27 July - 12 September. A September peak of 105,000 compared to 127,000 birds in 1977 suggested the roost size had declined slightly. However, counts were terminated two weeks earlier in 1978 than in 1977 and because of the subjective nature of such estimates, it would appear that the population remained relatively stable at around 100,000 blackbirds over the two years.

Particular flyways showed differences in numbers between the two years. An average decrease of 20,000 birds (24,000, 1977; 3,700, 1978) in a flyway to the west over Fesserton was perhaps the most noticeable. The largest flyway (south over Coldwater) exhibited an average increase of 15,000 birds (49,500, 1977; 64,000, 1978). The reasons for these apparent flyway population differences and the resulting impact on agricultural crops remain to be resolved.

Bird Marking Program

Banding and patagial tagging - An expanded banding effort in 1978 employing three standard decoy traps, two "Wings Inn" traps, and several territorial male traps resulted in the capture of 1563 birds (35.6% red-winged blackbirds). Cowbirds (Molothrus ater), grackles (Quiscalus quiscula), and starlings (Sturnus vulgaris) comprised 52.0, 5.6, and 1.7%, respectively, of the remainder. The increased capture success for red-winged blackbirds resulted in a greater proportion of adults available for banding and/or patagial tagging (42.4%, 1978; 13.4%, 1977).

Tagging of 415 red-winged blackbirds yielded 155 sightings in agricultural crops and other habitats. The majority of observations were within 3.5 - 4.5 km of the Matchedash Bay roost (max. distance 12.4 km). The marked birds regardless of age or sex exhibited similar movement patterns and foraging preferences for corn and small grains. Over 60% of all sightings were in field corn.

An 11-week comparison of the "Wings Inn" system of bird capture versus the use of standard decoy traps resulted in the processing of 1222 birds. Only 36% of the birds were captured in two "Wings Inn" traps. However, an evaluation based on traps of equal proportions may be more valid as the "Wings Inn" style was over seven times more efficient when results were expressed as numbers caught/unit volume (23.1 vs 3.2 birds/m^3).

The "Wings Inn" trap was unsuccessful in a limited trial designed to assess its potential for the removal of foraging blackbirds at a corn field. Although flock sizes ranged from 500-8000 birds per day in a 4 ha field, only 58 blackbirds were captured during a 25-day trial.

Radiotelemetry - Field application of a new technique for attachment of radio transmitters proved successful with male red-winged blackbirds. However, further alterations may be necessary if individual female movement patterns are to be assessed. Monitoring of 14 radio equipped red-winged blackbirds over a 55-day period disclosed an individual preference for specific foraging sites. However, the fidelity of marked birds for specific sites was not fixed in time and birds were observed to shift to other

locations. Thus, over the term of a crop's susceptibility to depredating blackbirds, considerable turnover of individuals may be occurring. This major observation could be of significance if a population management scheme was to encompass reduction of flocks at foraging sites. Telemetry observations also suggest that an apparent long term fidelity exists for specific sections of the cattail marsh roost at Matchedash Bay.

Feeding Ecology

Research focused on the impact of differential weed seed abundance within 4 corn fields (2 weedy, 2 non-weedy) on blackbird visitation pressure and associated corn damage. Study fields were selected subsequent to a systematic survey of the abundance of seed bearing weeds at potential sites. Temporal sampling of these alternate food sources was conducted in mid-July, and early and late August. Primary food sampling involved monitoring of corn moisture, potential corn kernel biomass, and damage at each site. Results of vegetative analyses are not yet available.

Blackbird pressure was assessed by early morning 2-hour observation of study fields by a systematic census following a shotgun discharge and by a census when fields were visited for collection of birds for gullet content analysis. Although compilations of bird pressure data are incomplete, preliminary average field values showed considerable variation. The sporadic nature of visitations noted at one field (weedy) resulted in the lowest percentage occurrence value for any field. Variances in bird numbers over three time periods during the shotgun census were not significantly accounted for across time during the census day, and thereby contradict the notion of temporally related feeding and rest peaks. However, telemetry observations indicated that non-foraging activities may occupy a portion of any given day. Thus, conclusions regarding bird pressure and subsequent crop loss must await the analysis of other visitation data and be evaluated in conjunction with the temporal susceptibility of corn for damage, weed seed abundance values, the time budget analysis data obtained from enclosure observations, and the analysis of gullet contents collected from depredating red-winged blackbirds at weedy and non-weedy fields.

Although gullet contents have not been analysed, the collection of birds at study fields supplied the following additional information. The age and sex profile of birds shot reflected the patagial tag observation that all age classes of both sexes were depredating corn fields. Fewest birds were collected at the field with the lowest observed average bird pressure. The field in question was within the Fesserton flyway which exhibited an average decline of 20,000 blackbirds. In addition, although only three starlings were collected, the presence of dough-stage corn in two birds' gullets may be of importance in that it is the first substantiated record of this species feeding on corn at this stage of maturity.

III. BLACKBIRD CONTROL

Control studies in 1978 were limited to further investigation on the effectiveness of Avitrol. Previous research had shown that Avitrol treatment resulted in an economic reduction in bird damage in some treated fields. In 1978, we wanted to study the effects of large scale Avitrol treatment on both treated and nearby untreated fields. However, Avitrol was

used only by a few growers in 1978. These data are now being analyzed. Generally, growers indicated that they were satisfied with the performance of the chemical.

10. Lowe, S. B. A study of land form alterations and establishment of plant species.

This grant was provided to the University of Guelph by the Ministry of the Environment to assist in establishment and operation of the Arboretum.

11. Mayfield, C. I. - Diquat in aquatic systems.

The chemical, physical and biological processes associated with diquat (Reglone$^{(R)}$) herbicide application to aquatic systems, especially sediments, were studied. The experimental systems used included:

i) Sediments containing high organic matter contents
ii) Sediments containing lower organic matter contents
iii) Model sediments varying in composition and containing known amounts of clay, silt, sand, organic matter and nutrients and of known pH, Eh, pO_2 and physical and chemical characteristics

Studies on adsorption/desorption phenomena, penetration into sediments, decomposition, transport and "carrying capacity" of various sediment types were carried out. Computer simulation studies were made, based upon the data generated, and were used to develop predictive models.

12. McEwen, F. L., Harris, C. R., Liu, H., and Ritcey, G. - Optimum methods for sterile male control of the onion maggot, Hylemya antiqua Meigen.

Two million sterile adults of Hylemya antiqua were released on the McGuire farm between 21 June and 21 September, 1978. They dispersed throughout the 12-hectare farm, and were recaptured on the periphery as well as in the centre of the field. Sterile to native ratios were higher (1.4:1) in interception traps placed up to 100 m from the release site than in those 200 m away (0.55:1), and higher still on sticky traps (7.2:1) at 40 m; 10.3:1 at 80 m). There was no difference between sterile to native ratios of immigrant and emigrant flies, nor in the numbers of sterile flies leaving and re-entering onions. Although sterile flies survived up to 27 days after release, the majority (75%) were found in the first week. Fertility of native females and damage to onions were assessed before, during and after the release period. Fertility of native females averaged 66.9% over the release period. By contrast it was 83.0% before and 89.0% after releases. First-generation onion maggots had damaged 30.0% of onions in the control bed (no insecticide) prior to releases, and damage had increased to 33% by the end of the release period. The remainder of the field had 7.3% damage before sterile flies were liberated, but no additional damage was detected. A modified spray program, in which the number of insecticide applications was reduced by timing them to coincide with peak numbers of adult flies, was conducted on 3 farms. Participating growers did not incur greater damage than those on weekly spray schedules.

13. McEwen, F. L., Surgeoner, G. A., and Helson, B. V. The biology and control of mosquitoes and other biting flies in Ontario.

Evaluation of the pyrethroids, permethrin, cypermethrin and fenvalerate for mosquito control.

In simulated pool trials during April and May (water temperature 19°C) cypermethrin and fenvalerate gave 95% control of Aedes stimulans group larvae and pupae at 10 g ai/ha. Permethrin was effective at 25 g/ha. In trials during July (water temperature 29°C) dosages of 25 g/ha for cypermethrin and 100 g/ha for permethrin and fenvalerate were required to give 95% control of Culex larvae and pupae. The differences in efficacy between spring and summer trials were probably due largely to temperature differences as all three pyrethroids were 2-3 times more toxic at 14°C than at 27°C in laboratory tests. During October (temperature 8°C) effective control of Culex larvae in simulated pools was obtained at dosages comparable to the spring trials.

In laboratory trials, the EC formulations of these pyrethroids were 4-5 times less toxic than the technical materials. The toxicity of fenvalerate EC was similar to the technical material in initial laboratory tests but declined in subsequent trials. Field observations also indicated such a reduction in toxicity.

As mosquito adulticides, cypermethrin and fenvalerate provided 98-100% control of caged Culex females at 6 and 12 g ai/ha. Permethrin was very effective at 18 g ai/ha. These pyrethroids, particularly cypermethrin, are promising new mosquito larvicides, pupicides and adulticides.

Resistance monitoring of Culex and further studies on the susceptibility of mosquitoes to temephos.

In 1977, a baseline LC_{50} value of 1.04 ppb was established for susceptible populations of 4th instar Culex pipiens and restuans larvae to temephos at 19°C. In confirmation, a value of 1.04 ppb was again obtained in 1978 for such populations. Culex larvae from temephos-treated sites in Essex and Niagara counties gave LC_{50} values of 0.97 ppb and 0.96 ppb respectively. No evidence of insecticide resistance presently exists in southwestern Ontario.

Additional tests with temephos were performed in 1978 to establish and confirm susceptibility baselines for spring Aedes species larvae. LC_{50} values for Ae. stimulans, Ae. fitchii and Ae. euedes were 5.1, 2.9 and 2.4 ppb respectively. A study was also begun in 1978 to determine the effects of larval age and water temperature on the susceptibility of mosquitoes to temephos. Susceptibility was positively correlated linearly with temperature and negatively correlated with larval age. Second instar Ae. euedes larvae at 19°C exhibited an LC_{50} value of 0.06 ppb while late 4th instar larvae at 4°C exhibited a value of 8 ppb representing more than a 100 fold difference in susceptibility. Such differences have potential implications for the timing and dosages to use in field treatments with temephos.

An evaluation of Blitz-Foggers(R) for backyard mosquito control.

In a backyard with an area of ca. 3,500 sq. ft., Blitz-Fog treatments at the rate of 2 fl. oz./1,000 sq. ft. reduced mosquito landing counts by ca. 70%*, 15 minutes after treatment. No reductions in biting activity were observed 30 minutes after treatment. In a yard with an area of ca. 10,500 sq. ft., treated in a similar fashion, mosquito landing counts were reduced by 80%* for approximately 45 minutes after treatment and reductions of ca. 65%* were observed 90 minutes after treatment. Caged-trials showed that the Blitz-Fog containing .2% pyrethrins, .4% piperonyl butoxide and .67% N-octyl biocycloheptene dicarboximide did not kill mosquito adults which indicates a repellent effect of the treatments.

Evaluation of several insecticides for mosquito control in Ontario.

In 1977, the effectiveness and residual activity of Altosid(R) SR 10 and Altosid(R) briquets against Culex larvae were found to be very similar in simulated pools. In 1978, these formulations were evaluated against Culex larvae in natural catch basins ca. 1-3 cu. ft. in size. Within 5 days after treatment, the briquet formulation gave 95-100% control which lasted at least 12 weeks in 2 catch basins treated with 1 briquet each. At an equivalent dosage the SR 10 formulation provided 90-100% control for 8-12 weeks in 4 catch basins.

Because of their potential safety, specificity and relatively low cost, three monomolecular surface films were evaluated in simulated pools at dosages of 0.04-0.4 ml/sq. m. for their effectiveness as pupicides and larvicides. In a preliminary trial, sorbitan monooleate gave 98-100% control of spring Aedes pupae and larvae within 24 and 48 hrs respectively at 0.2 ml/sq. m. At 0.4 ml/sq. m. oleyl ether and isostearyl alcohol were less effective and slower acting. None of these compounds provided consistently good control of Culex pupae or larvae.

A preliminary trial with a new chitin-inhibiting insect growth regulator, Bay SIR 8514, was conducted in simulated pools with 4th instar Culex pipiens larvae. At 50 g ai/ha, a WP and EC formulation both gave 100% control of larvae present at the time of treatment. Residual activity was short for both formulations. At lower dosages the WP formulation appeared more active than the EC formulation.

Because extensive Culex breeding was reported in catch basins during 1978, trials were performed in simulated pools to determine the comparative effectiveness and residual activity of temephos. chlorpyrifos, fenthion, malathion and methoxychlor EC formulations at maximum recommended dosages. All compounds provided 100% control of 4th instar C. pipiens larvae present at treatment time. Only chlorpyrifos and temephos gave 90% control 4 days after treatment. Seven days after treatment 50% control was obtained with chlorpyrifos while no control was evident with the other compounds.

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* as compared to nearby untreated yard.

Ecopro(R), a controlled release formulation of temephos, was also evaluated in simulated pools according to manufacturer's recommended dosages and theoretical mode of action (chronic stress). Although the results have not been analysed completely, satisfactory sustained control of Culex larvae was evidently not achieved with any of the 3 formulations tested.

In 1978, the organophosphorus insecticide, azamethiphos was evaluated as an adulticide against caged Culex females using a London Aire XK, ultra low volume aerosol generator. A new formulation provided good control at 18 g ai/ha with most mortality occurring within 6-12 hrs. Droplet sizes were within specifications and required flow rates could be obtained at vehicle speeds of 8 km/h.

The bionomics of Culex pipiens and Culex restuans in relation to control. (D. J. Madder)

Populations of Culex pipiens and Culex restuans were monitored throughout the 1978 season by determining the number of egg rafts laid in a series of 9 artificial pools located at Guelph. C. pipiens had 3 to 4 generations with first oviposition occurring on May 23 and last on September 30. C. restuans had 2 to 3 generations with first oviposition on May 17 and last on October 15. The first generation of C. pipiens showed a fecundity of 194 eggs/raft while the subsequent generations had an average of 296 eggs/raft. C. restuans maintained a fecundity of 199 eggs/raft throughout the summer. Evidence from this study would indicate that those eggs oviposited from late July on (the third and fourth generations of C. pipiens, and the third of C. restuans) will produce adults that are in diapause and thus refractory to blood-meals. Mosquito larviciding for Culex sp. in southern Ontario should therefore be concentrated during the period from early June to early August. Control of the diapausing generation is not necessary as natural mortality is greater than 95% during the winter.

Studies on the biology of Coquillettidia perturbans with reference to its control. (S. A. Allan)

C. perturbans populations were monitored with dry ice-baited CDC light traps, biting collections, emergence cages and egg-raft collections from June to September, 1978. Adults were collected in emergence cages from ca. June 7 to August 16. There were 2 major peaks comprising 33% and 64% of the total adults collected. These peaks in emergence are probably the result of different overwintering larval instars. Adults were captured in CDC traps from June 13 to September 8. As in 1977, maximum numbers of over 18,000 were collected in mid July. The daily biting activity, as determined hourly throughout several 24-hour periods, exhibits major peaks of activity at sunrise and sunset comprising 47% and 38% respectively of the total biting activity of the day. Much of the activity occurred during the hour after sunrise and sunset. Oviposition occurred from June 30 to August 31 with a peak in early July.

Adulticiding in late June and July, concentrating operations during sunrise and sunset, is at present the most effective means of controlling this species.

A method to rear larvae in artificial pools in the field has been developed. This has potential for use in future research on the larval control of C. perturbans.

14. Pengelly, D. H. and W. D. Husby. - The ecology of subterranean termites in Ontario.

A surveillance of ground dwelling colonies of Reticulitermes flavipes (Kollar) was maintained from April 26, 1978, when surface activity was first noted, to September 26, 1978, when the majority of the members of a colony had withdrawn three to four feet into the soil. Colonies were sampled from infested areas at weekly intervals. Field dwelling colonies in Guelph, Fergus, and Leamington were studied. Changes in the proportion of castes within field colonies as the year progressed were investigated. Laboratory colonies of termites collected at different times of the year, and containing various proportions of the different castes, were observed at weekly intervals.

Flight of the alate caste was not observed. However, small numbers of alates, never exceeding 0.08% of a single colony, were present in colonies collected in June. Large numbers of supplementary reproductives, eggs, and early instar young were present in colonies from June 15 to July 14. No eggs or physiogastric queens were found after July 14. However, lab colonies continued to produce eggs throughout the summer. The proportion of soldiers within a colony was small, ranging from 0.4% to 2.9%.

Several investigators believe that the Canadian and northern U.S. population of this termite could well be a separate cold-adapted race or subspecies of R. flavipes. Certainly, aspects of the biology and behavior of this population are proving to be quite different from those of populations further south. Since the range of this termite is expanding in southern Ontario, it is important that knowledge of its biology be incorporated into present and future control programs.

15. Rowsell, H. C. - Assessment of pain and distress caused by vertebrate pesticides.

The evidence that many in the general public are concerned about killing animals is obvious by the annual furor over the killing of harp seal pups. Unfortunately, many well-meaning and concerned members of the general public fail to reflect this level of concern over the killing of pest animals and thus unwittingly establish first class and second classes of animals.

All animals can experience pain, as they all possess opiate receptors and encephalins in their central nervous system which are structures and substances recently discovered. Encephalins are part of the body's protective biochemical system for coping with pain and stress. It is said that human beings who can stand more pain than others may be able to call forth extra supplies of encephalins. A low tolerance for pain may mean a deficiency in either opiate receptor sites or encephalins.

We have no way at present of measuring the number of opiate receptors or encephalin levels in animals. Therefore, in assessing pain and distress in animals we are forced to measure subjective signs such as vocalizing, shivering, trembling etc. and electroencephalograms. At the time of death the latter is of specific value, as is the loss of the blinking reflex which indicates unconsciousness and insensitivity to pain.

Vertebrate pesticides have been assessed in the laboratory rat and the white carneau pigeon on the basis of the clinical signs and behaviour, during exposure to the pesticide. Electroencephalograms have been recorded during exposure and terminally. The behaviour and function of the animal has been assessed prior to and when unconsciousness occurs. Emphasis has been placed on the response of the animal to Avitrol, anti-coagulant agents, and Vacor.

16. Sears, M. K., and C. P. Dufault. - Baited insecticides for control of adult cabbage maggots on rutabagas.

Laboratory experiments to determine the attractiveness of various bait substances are in progress. Rutabaga leaves treated with 10 and 25% solutions of molasses, yeast hydrolysate, or honey are being compared to an unsprayed leaf and to each other for their attractiveness to adult cabbage maggot flies. Flies are observed as they alight and feed on the leaves every 10 minutes over a one hour period. These observation cages are replicated at least six times. Preliminary results indicate that yeast hydrolysate and molasses are attractive at a 10% concentration but not significantly greater at 25%. Much more investigation into this aspect of the project is needed for future application to field situations.

Contact toxicity studies have been performed to select candidate materials for bioassay and field trials. Results indicate that the pyrethroids, permethrin and cypermethrin, and the organophosphorus compound, parathion, show the greatest toxicity (ca. 5 ppm LD_{50}) to adult cabbage maggots. Other materials tested include fenvalerate, diazinon, fonofos, carbaryl and dimethoate. These experiments are continuing.

Bioassay experiments in which rutabaga plants were treated with various insecticide and insecticide-bait combinations indicated that diazinon and permethrin caused ca. 40% mortality to flies caged on leaves treated seven days previously. All other materials were no longer effective after three days. Parathion, in combination with various bait materials, was tested in the same manner. Parathion (0.28 kg ai/ha) combined with a 1% yeast hydrolysate soltuion produced 55% mortality to fies caged on treated leaves five days after treatment. All other baits combined with parathion and parathion alone were effective for only three days. When molasses or yeast hydrolysate were combined with the spreader sticker, Plyac(R), both produced 50% or greater mortality seven days after treatment. Further bioassay experiments are planned which will determine the effect of increasing concentrations of bait materials on the duration of insecticidal effect of those materials showing promise in the contact toxicity studies.

During summer 1978, adult fly populations were monitored using sticky traps and cone traps. The sticky traps proved more consistent in attracting and capturing flies, especially in the late part of the season when plants become mature. Peak fly activity periods were monitored and several experiments were conducted to determine the effect of insecticide treatment on the adult flies. Commercial fields were used, one-half of the field being sprayed with parathion (0.28 kg a.i./ha), the other one-half serving as a check. Sticky traps were used to monitor flies in each half before and after treatment. Of the six fields in which experiments were conducted, only four fields had sufficient flies for observation. In the remaining four fields, the treated half had significantly fewer flies one day after treatment, but after two days both the treated and the untreated half no longer had sufficient trap catches for comparison. In this case, it was felt that movement of flies throughout the field caused considerable mortality of the resident population. Most of the flies trapped after this time were found on traps near edges of the fields indicating some movement of flies into the area from elsewhere. During 1979, entire isolated fields will be treated and monitored. The most promising insecticides and insecticide-bait combinations will be utilized.

17. Svec, H. J., Miles, J. R. W., and Harris, C. R. - Development of effective monitoring techniques and control programs for insect pests attacking vegetables grown in the Thedford Marsh.

Emphasis was placed on all six objectives outlined in the research proposal.

Biological studies indicated important differences in behaviour of the onion maggot in the Thedford Marsh as compared to other organic soil areas in Ontario. High levels of overwintering pupae were present in the Thedford Marsh in 1977 (avg. 88,572/acre) as compared to the Keswick Marsh (avg. 7,260/acre). In the spring of 1977 the onion maggot caused serious damage to Dutch Set onions (up to 30% of some fields destroyed). Laboratory studies indicated that, in contrast to the Holland Marsh, the onion maggot was still susceptible to organophosphorus insecticides. This suggested that current recommendations for onion maggot control were not adequate, or that the growers were not utilizing recommended insecticides in the proper fashion. The 1977 infestation was brought under control by advising growers to adopt an intensive adulticide spray program using parathion. The overwintering pupal population in 1978 was reduced to an avg. of 9,317 pupae/acre. Pupal density in fields varied with onion variety grown and cultural practices followed in the previous year. Fields where reject onions sprouted in fall attracted 3rd generation flies resulting in a heavy overwintering population in these fields. Clean fields had very low overwintering populations. Through cultural practices overwintering pupae were distributed through the upper 8 inches of soil. Differences in soil temperature resulted in a prolonged period of emergence (ca. 1 month). Some first generation adults were still alive as second generation adults began to emerge and some of the latter were still present as third generation adults emerged, i.e. flies were present at all times from mid-May to early October. Three different monitoring techniques (pupal emergence cages, flight interception cages, net sweeps) proved effective in predicting emergence dates, size of the adult population, and host plant preference). Adults showed marked preference for different onion varieties: in May/June the order of preference was Sets from seed>Dutch sets>pickling onions>dry onions; in July: Sets from

seed pickling onions>dry onions>Dutch Sets; in August/September (when the early onion varieties had been harvested) flies were attracted to dry onions.

Crop loss estimates were obtained using large plots established on acreage rented from one grower. In the absence of insecticide treatments, onion maggot caused 2.8, 30.8, 30.6, and 22.9% damage to Dutch Sets, pickling onions, sets from seed, and dry onions, respectively. Based on yield/acre and value of the crop, potential crop loss would be $44, 862, 845, and 401 (estimated)/acre for Dutch Sets, pickling onions, sets from seed, and dry onions, respectively.

The effectiveness of seed furrow treatments currently recommended for 1st generation onion maggot control for dry and pickling onions was assessed in microplot tests at the Research Institute field station in London. Using an insecticide-susceptible strain of onion maggot, fonofos (1.0 lb AI/acre) was most effective on dry onions>carbofuran (1.5 lb) = fensulfothion (1.0 lb)>ethion (2 lb). Effectiveness varied with row width. At the application rates used the insecticides were effective with row widths of 3/4 and 1½ inches, less so in 3 inch rows. With pickling onions (3-4 inch rows) the order of effectiveness was fonofos (2 lb AI/acre) > chlorpyrifos (2 lb)> chlorfenvinphos (2.1 lb)>fensulfothion (2 lb) = ethion (4 lb)>carbofuran (3 lb). At ½ rates of application, significant damage occurred in all cases. Field trials were conducted at the Thedford Marsh with grower cooperation. Fonofos was used as the seed furrow treatment and adulticide sprays were timed on the basis of the adult monitoring program. Excellent onion maggot control was obtained with all four onion varieties as follows:

Dutch Sets: Seed furrow treatment + 6 sprays, 0.3% damage (2.8% in control)
Pickling onions: Seed furrow treatment + 6 sprays, 0.9% damage (30.8% in control)
Sets from seed: Seed furrow treatment + 8 sprays, 0.0% damage (30.6% in control)
Dry onions: Seed furrow treatment + 9 sprays, 0.0% damage (22.9% in control)

Studies on levels of insecticide residues in Thedford Marsh soils were continued. A survey initiated in 1976 was completed and the results published. In general insecticide residues in Thedford Marsh soils (avg. 7.8 ppm) were much lower than in Holland Marsh soils (avg. 22.5 ppm). A more comprehensive soil insecticide residue survey was initiated. Residues in onions resulting from current control programs and residues in crops resulting from experimental control programs are being determined. A chance observation during analysis of some Thedford soils for OP insecticides suggests that residues of at least one herbicide may be quite high in some of these soils.

Results obtained in the pest monitoring program were used to advise growers (through cooperation with the Ontario Ministry of Agriculture and Food) as to initiation and timing throughout the season of sprays for onion maggot control. In addition Agricultural Research Institute staff visited the marsh three times a week to carry out the pest monitoring and insecticide control programs. During these visits they contacted key growers and provided current information and advice. Many growers adopted the pest monitoring recommendations, and generally obtained good results. A number of growers who did not follow recommendations sustained light to severe onion maggot damage to their crops.

One grower who applied the seed furrow treatment too deep and mistimed his adulticide sprays sustained >60% damage in a 20 acre field of dry onions, i.e. a loss of >$21,000 (assuming a value of $1,750/acre).

Laboratory studies were conducted to assess the contact toxicity of a number of insecticides against onion thrip. Of 16 insecticides tested the most toxic were FMC 45498>mevinphos>dimethoate>parathion>malathion>chlorpyrifos. When formulated insecticides were applied to onion plants in the laboratory Pencap E and chlorpyrifos at 0.3 and 0.5 lb AI/acre respectively provided effective thrip control for 18 days. Mevinphos at 0.25 lb AI/acre was effective for 15 days, diazinon and azinphosmethyl at 0.5 lb AI/acre for 6 days. Permethrin applied at 1 oz AI/acre was effective for 6 days. In microplot field tests three pyrethroid insecticides, i.e. WL 43775, permethrin (Ambush), and WL 43467 applied at 1 and 2 oz AI/acre effectively controlled cutworms attacking lettuce. Chlorpyrifos at 16 oz AI/acre also gave effective control. None of the insecticide treatments was phytotoxic. Insecticide residues present on the crop at harvest are being determined. General observations made during the summer at the Thedford Marsh indicated that Colorado potato beetle can be a serious problem. Many growers used aldicarb which, with one exception, gave effective control.

18. Tomlin, A. D., and Broadbent, A. B. - Feasibility of using the litterbag technique as an index of the environmental impact of soil insecticides on soil fauna.

Nylon fabric bags (10 cm X 10 cm) of three mesh sizes, 0.005 mm (S), 0.7 mm (M) and 9.0 mm (L), which exclude soil invertebrates of different size classes, were filled with a measured area of leaf tissue and buried (3-5 cm) in soil. The litterbags were unearthed after various intervals throughout the year to measure the remaining leaf area, and leaf decomposition rates based on area reduction were determined.

The five sites selected for a study of baseline decomposition rates for a variety of leaf species (corn, apple, maple, beech) were a Guelph cornfield, pasture and orchard, a London pasture, and a deciduous wood. Cornleaf decomposed faster in the cornfield than in the Guelph pasture or orchard system. In the London pasture and deciduous wood the rate of leaf decomposition was: corn>apple>maple>beech. A uniform artificial substrate, cotton fabric, was also tested in a search for a reliable, standardized test material. Rather than area reduction, loss in tensile strength was measured as an index of decomposition.

Soil cores (15 cm X 5 cm) were taken from the various sites on several dates, and the resident soil microfauna extracted by Tullgren funnels.

To test the feasibility of using the litterbag technique for studying the impact of insecticides on the decomposer organisms in soil, carbofuran was applied to the cornfield. Cornleaf in litterbags was subsequently buried and cornleaf decomposition rates for treated and untreated plots were determined for the summers of 1977 and 1978. The rate of cornleaf disappearance was correlated with mesh size: L-mesh>M-mesh>S-mesh, indicating the importance of soil fauna in mediating the decomposition process. In 1977 the decomposition rate of cornleaf in the carbofuran treated plot was consistently less than the control plot for large and medium mesh bags, which

suggested reduction in numbers or activity of the decomposer fauna by carbofuran. In 1978 no significant difference in decomposition rate was noted for the large or medium mesh bags between treated and untreated plots.

Soil cores taken 4 weeks (1977) and 2.5 weeks (1978) after carbofuran row-treatment showed a significant decline in the Isotomidae (Collembola) population and a significant increase in the Prostigmata (Acari) population. Five months after treatment there was no significant difference in the Prostigmata population or biomass of earthworms when compared to untreated plots but an increase in Isotomidae in the row-treated plot and a significant decrease in numbers of earthworms in a broadcast treated plot was observed.

19. Tu, C. M., Chapman, R. A., and Spencer, E. Y. - Microbial degradation of pyrethroid insecticides in soil.

Samples of sterilized and non-sterilized sandy-loam and muck soils contained in glass bottles were treated individually with permethrin, cypermethrin, fenpropanate, fenvalerate, decamethrin, parathion or DDT at 1 ppm using techniques developed previously to minimize microbial contamination of sterilized soil and solvent sterilization of natural soil. Parathion and DDT were included as test materials to provide correlation with similar work on OP insecticides done previously and as a test for the development of anaerobic conditions, respectively. Triplicate samples were taken periodically over 16 weeks for the analysis of microbial populations and the extraction of insecticide residues. Bacterial and fungal populations were monitored as an indication of microbial activity. Sterile conditions (<2500 colonies/g) were maintained for at least 8 weeks in most of the samples. No long term effects of the insecticides on natural microbial populations were observed. Residue analyses have not been completed but significant differences in persistence between sterilized and non-sterilized samples have been observed in most of the soil-insecticide combinations analyzed to date.

20. Turner, C. J. - The effects of pesticides upon the growth of nerve endings.

Many pesticides present a neurotoxic hazard, in particular to agricultural workers, livestock and wild animals living in the environment. These compounds, in sufficient concentration, are known to cause neuronal death or axon and nerve terminal degeneration. The aim of this study was to determine whether or not the pesticides in common use can have more subtle effects. Specifically, can pesticides disrupt the normal functioning of the nervous system by inhibiting the ability of nerves to grow?

At present the project is in the preliminary stage of establishing a model to permit a quantitative study of nerve growth. An initial attempt was made to establish a model for nerve growth in rat salivary glands following partial sympathetic denervation. The model was chosen because:- a) nerves commonly grow and reinnervate denervated sites in a partially denervated tissue; b) sympathetic nerves can be visualized very easily; c) partial sympathetic denervation of rat salivary glands is a simple procedure. Crushing the superior cervical ganglion immediately rostral to the ventral post-ganglionic output produced a partial sympathetic denervation which was consistent from animal to animal (18% ± 3% S.E.M., n = 8), in the

submaxillary salivary gland. However, in a further group of seven rats, left an average of one month following partial denervation, nerve growth appeared to occur in only two. Nerve growth was suggested by a statistically significant return of the density of innervation towards the control level. The reason why all animals did not produce nerve growth is unclear but the poor growth response following partial denervation makes this an unsatisfactory model for testing the ability of pesticides to inhibit nerve growth.

Accordingly, the establishment of another model of nerve growth has now been undertaken. When an axon is crushed, the axon and nerve terminals distal to the injury degenerate, but the nerve responds with a regenerative growth and the original morphology of the neurone is re-established. Preliminary results have demonstrated that a crush of the sympathetic nerves within 1 mm of their entry point into the rat submaxillary gland produces an almost complete sympathetic denervation (approximately 98%) within two days. Within three weeks of the initial operation there is sufficient nerve growth to restore the density of innervation to approximately 50% of normal values. Furthermore, though the number of animals is small, nerve growth has been a consistent finding. This suggests that this will be a successful model for the quantitative study of nerve growth and all that remains to be determined is the time course of the nerve growth.

Research proposals funded in 1977-78 and completed in 1978-79.

21. Fushtey, S. G. - Efficacy of fungicides for the control of snow mold in fine turfgrass.

During 1977-78 a study was conducted to determine the efficacy of fungicides available for the control of snow mold in fine turfgrass. The experiments were conducted on golf greens at 8 different sites: 1 in Barrie, 2 in the Toronto area and 5 in the Guelph-Cambridge area. Each experiment consisted of 18 different treatments representing 11 different products.

Where disease severity was low (less than 10 percent) all the products gave satisfactory control. At one site (Puslinch), where disease was moderately heavy (65 percent) and caused by Typhula sp. alone, satisfactory control was obtained with all products but Tersan 1991 (benomyl) which is known to be ineffective against this fungus. Good control was obtained with Tersan SP (chloroneb), Arrest (thiram-carbathiin), Quintozene, Bravo F54 (chlorothalonil), Caloclor (mercury), Rovral (26019 RP), Baymeb 6447 (experimental), Proturf (PCNB), Proturf (chloroneb), Proturf (PMA-thiram) at appropriate dosages. At Barrie, with extremely heavy disease (95 percent) caused by Typhula sp., only 3 products, the 2 containing mercury and Bravo F54 at the higher dosage, controlled the disease. At Guelph (Cutten) with heavy disease (85 percent) caused by a Fusarium-Typhula complex only products containing mercury and quintozene gave control.

Fungicides containing mercury were the only ones that gave consistently good control at all sites. The narrower spectrum fungicides are subject to variations in field circumstances.

22. Miles, J. R. W. and Moy, P. - Carbofuran residues in organic soils in southwestern Ontario.

Organic soils of 22 farms with a history of carbofuran treatment for control of onion maggot or carrot rust fly were sampled in November 1977. Analysis for carbofuran was by electron capture gas chromatography of the heptafluorobutyric-derivative. Only 8 of the 22 soils contained >0.5 ppm total carbofuran. In 3 soils no carbofuran was detected (sensitivity 0.02 ppm). The greatest total carbofuran residue was 1.46 ppm of which 0.31 ppm was the 3-ketocarbofuran metabolite. In the other farm soils 3-ketocarbofuran comprised 9-50% of the total carbofuran residue. No 3-hydroxycarbofuran was detected. Furrow treatments with 3 granular insecticides indicated that persistence in these organic soils was in the order ethion>fonofos>carbofuran. Carbofuran does not appear to be accumulating in organic soils of southern Ontario.

23. Miles, J. R. W. and Moy, P. - Microbial degradation of endosulfan.

Alpha-endosulfan, β-endosulfan and their metabolites endosulfan sulfate, endosulfan diol, endosulfan ether, endosulfan α-hydroxyether, and endosulfan lactone were separately incubated with a mixed culture of microorganisms from a sandy loam soil. There was some inter-conversion of α- and β-endosulfan but the greatest conversion was to endosulfan diol (74 and 77%). Significant conversion to the diol also occurred in the sterile nutrient medium (31 and 43%). The endosulfan diol was converted to the α-hydroxyether which was 87% converted to the endosulfan lactone. The endosulfan lactone disappeared rapidly (half-life 5.5 h) even in the control medium. The production of endosulfan diol in these aqueous incubations is in agreement with published reports on endosulfan conversion to the diol in soil under flooded conditions. In the organic soils of southern Ontario we have found endosulfan sulfate to be the terminal residue from endosulfan usage, but these incubations in aqueous medium are probably a good indication of the fate of endosulfan residues in streams.

APPENDIX IV. Publications relating to the Ontario Pesticides Advisory Committee Research Programs, April 1, 1978 - March 31, 1979

Corke, C. T., Bunce, N., Beaumont, A. and Merrick, R. Diazonium cations as intermediates in the microbial transformation of chloroanilines to chlorinated biphenyls, azocompounds and triazenes. Jour. Agric. Food Chemistry. In press.

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